Itanium® Processor Family: Leaping ahead with Quad-core Tukwila

Rohit Bhatia
Principal Engineer
Intel Corporation

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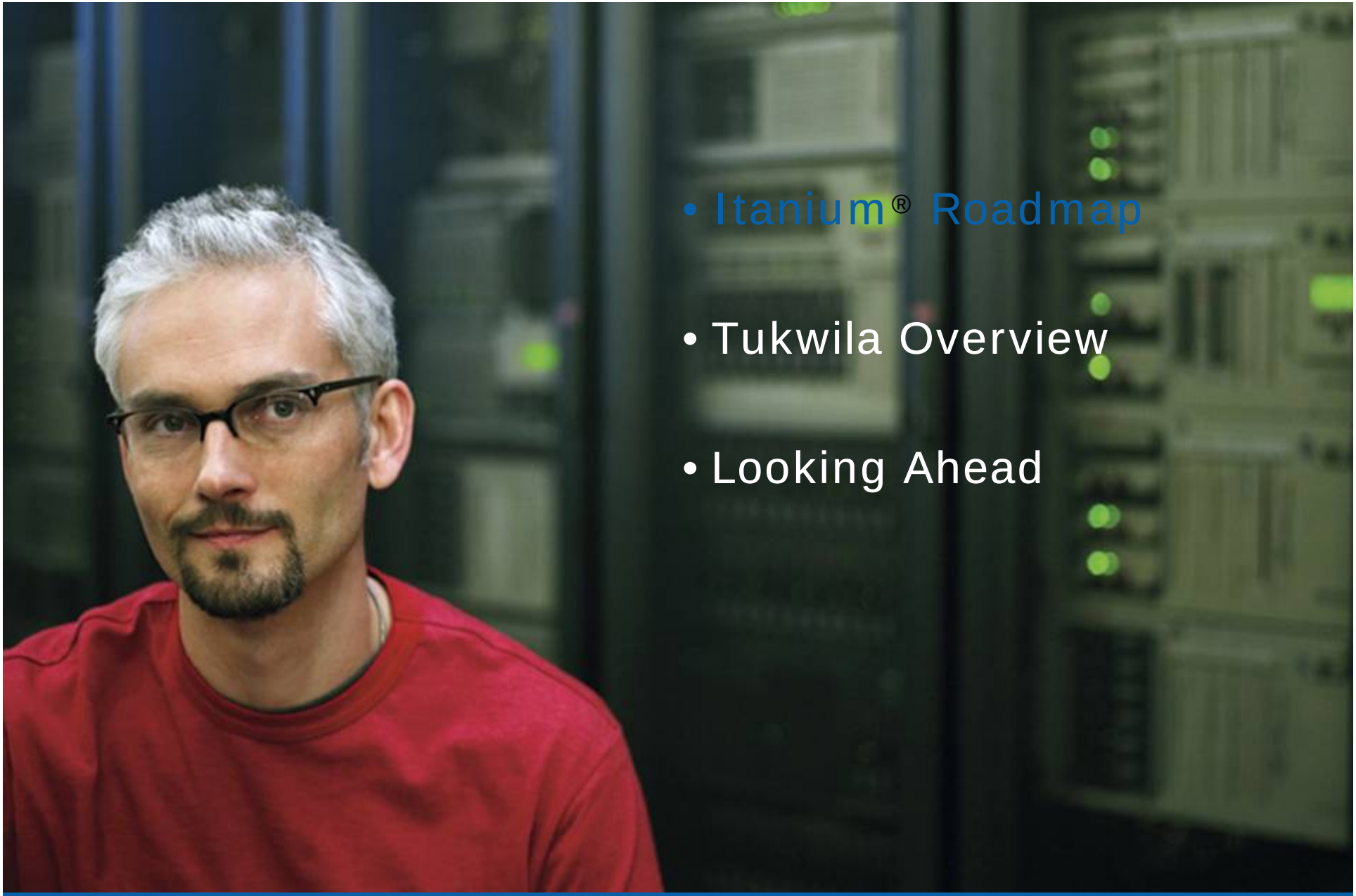
Agenda

Itanium® Processor Roadmap and Momentum

Tukwila Overview
- “2 billion transistors”

IPF Future Microarchitecture
- “Parallelism at all levels”



- Itanium® Roadmap
- Tukwila Overview
- Looking Ahead

Intel® Itanium® Processor Family Roadmap

Processor Generation	Intel® Itanium® Processor 9000, 9100 Series	Tukwila	Poulson	Kittson
Highlights	**Dual Core**	**Quad Core (2 Billion Transistors)**	**Ultra Parallel Micro-architecture**	
New Technologies	• 24MB L3 cache • Multi-Threading (MT) Technology • Intel® Virtualization Technology • Intel® Cache Safe Technology • Lock-step data integrity technologies (9100 series) • DBS Power Management Technology (9100 series)	• Quad Core, 6M L3 Cache per Core, MT Technology • Dual Integrated memory controllers, 4 Channels • QuickPath Interconnect • Advanced RAS (interconnect, Memory (DDDC)) • Enhanced virtualization • Common chipset with Intel® Xeon® processor MP • Voltage Frequency Mgmt • >2x Perf Vs 9100 Series	• Advanced multi-core architecture • Multi-threading enhancements • Instruction-level advancements • 32nm process technology • Large On-Die Cache • New RAS features • Compatible with Tukwila platforms	9th Itanium® Product
Targeted Segments	***Enterprise Business (Database, Business Intelligence, ERP, HPC, …)***			
Availability	2006-07	End 2008	Future	Future

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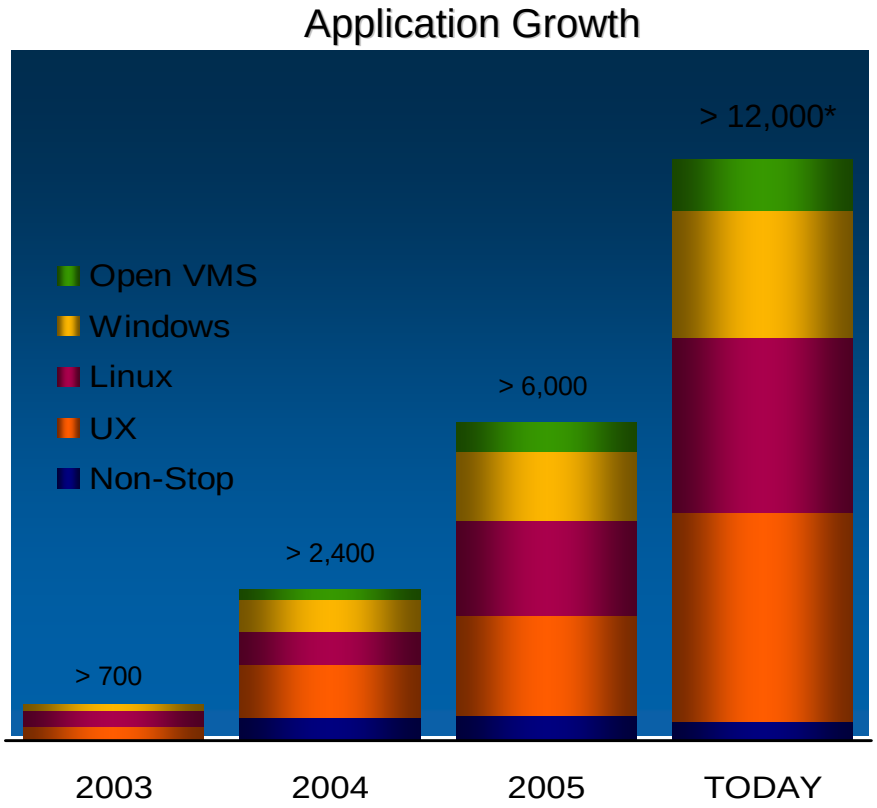
Intel® Itanium® Processor Ecosystem



SAP runs SAP on Itanium® 2 processor:

"For our new ERP landscape, we needed a largely standardized and automated infrastructure that would not require as much manual intervention as in the past. Scalability was also essential. Greater performance and flexibility for the same price was an outstanding argument for switching to HP Integrity servers with Intel® Itanium® 2 processors."

— Martin Heisig, Chief Operations Officer SAP IT

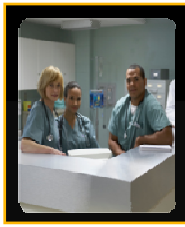
- Itanium Solutions Alliance $10B investment on-track
- Sun Java SE* support for Itanium® processor family

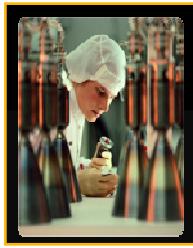
[1]Source: Itanium Solutions Alliance *Other names and brands may be claimed as the property of others

Strong End-user Adoption

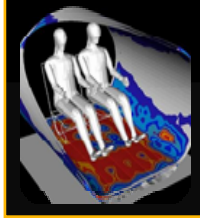
>140,000 deployments, 75 of top global 100 companies

World's Largest Stock Exchanges
8 of the Top 10 Financial Services Companies*



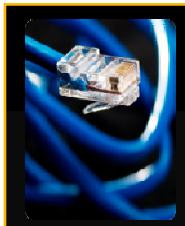


Manufacturing
13 of the top 15 Manufacturing Companies*



Efficient Automobiles
12 of the Top 13 Automobile Manufacturers*

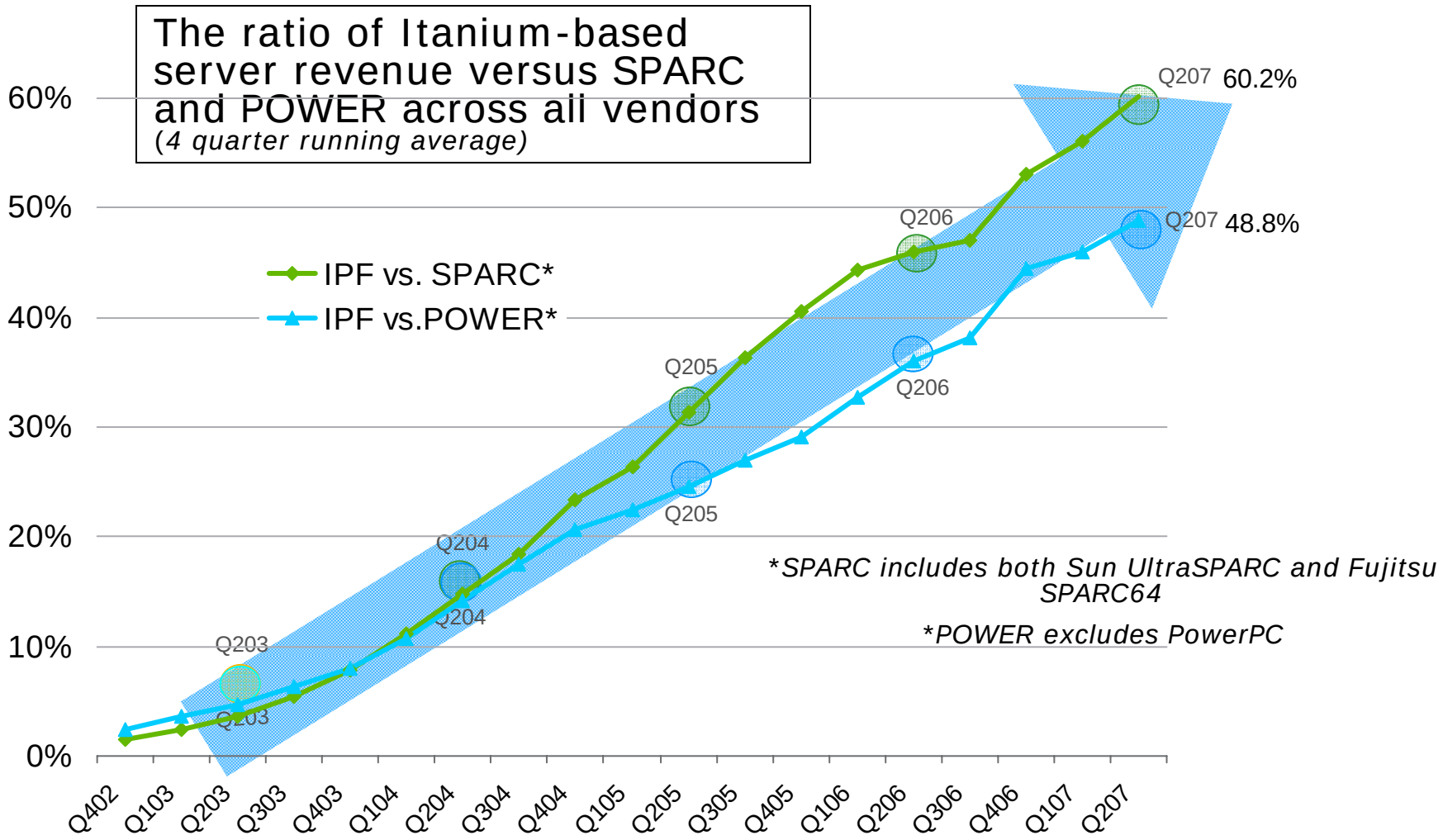
Recovery
14 of the top 15 Energy Companies*



Communication Products and Services
Most of the top Telecom Providers*

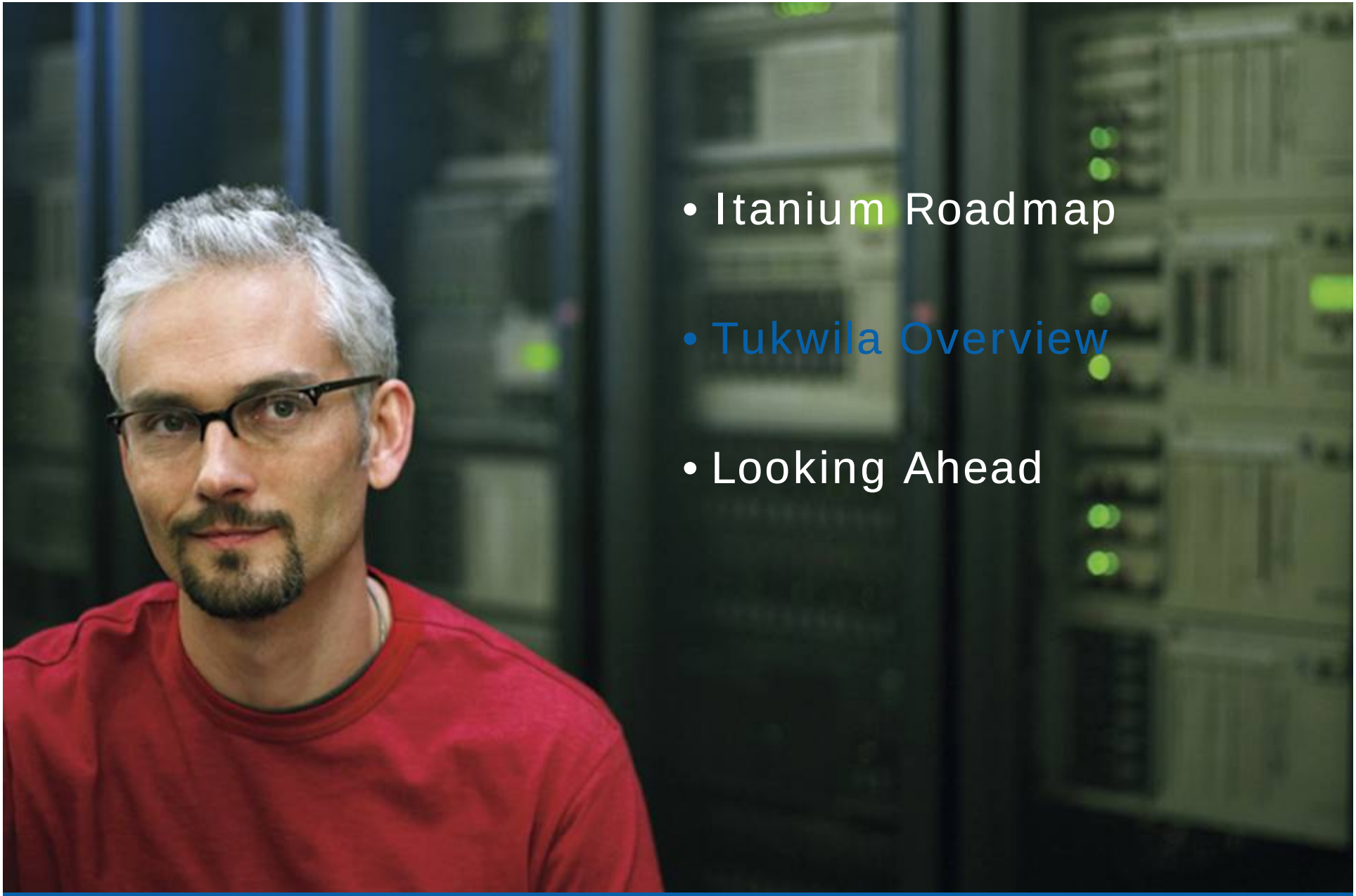
*Source: Intel Corporation

Itanium Server vs. POWER and SPARC



Ratio based on factory revenue
(*4 quarter running average*)

source: IDC Worldwide Quarterly Server Tracker, August 2007



- Itanium Roadmap
- Tukwila Overview
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Intel® Itanium® Processor (Tukwila) Overview

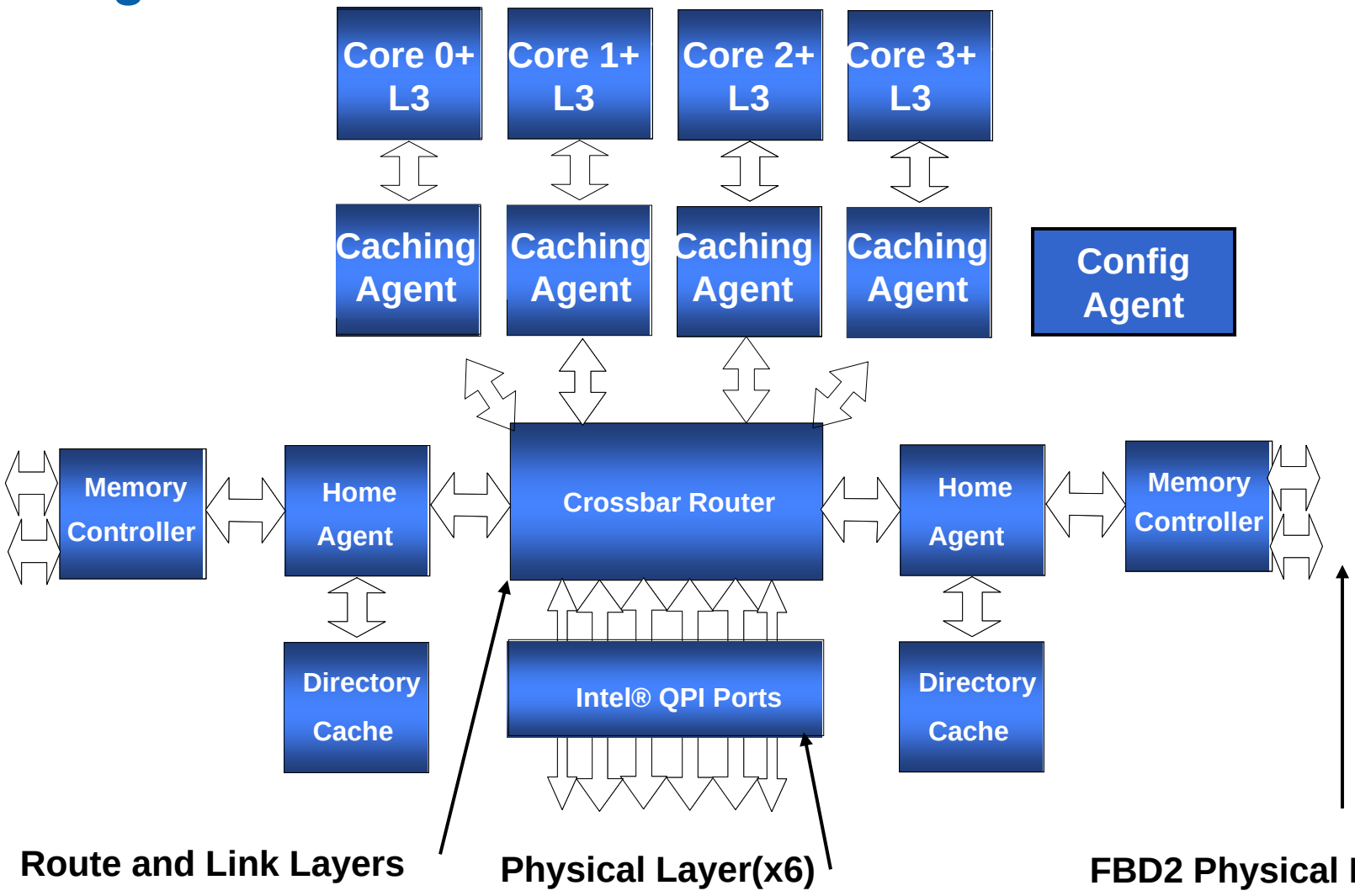
- **Intel Itanium processor's (Tukwila) 2 billion transistors implement multi-core architecture with four cores per die, 30MB of total cache, two memory controllers, and one router.**

- **High-bandwidth, low-latency point-to-point Intel® QuickPath Interconnect and FBD2 channel technology**
  - 4.8GT/s Intel QuickPath Interconnect and Memory Interconnect
  - 96GB/s total Intel QuickPath Interconnect
  - 34GB/s total memory bandwidth

- **Provides glue-less SMP up to 8 sockets:**
  - 4 full-width links plus 2 half-width links

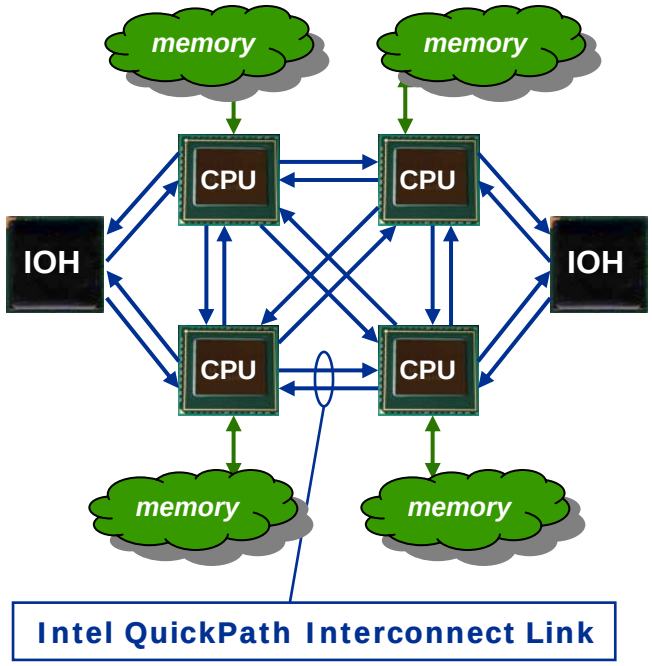
Quad-Core Design with a new high bandwidth socket

Intel® Itanium® Processor (Tukwila) Block Diagram

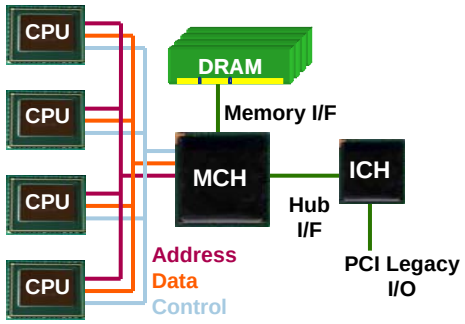


Intel® QPI = Intel® QuickPath Interconnect

Intel® QuickPath Interconnect



FSB



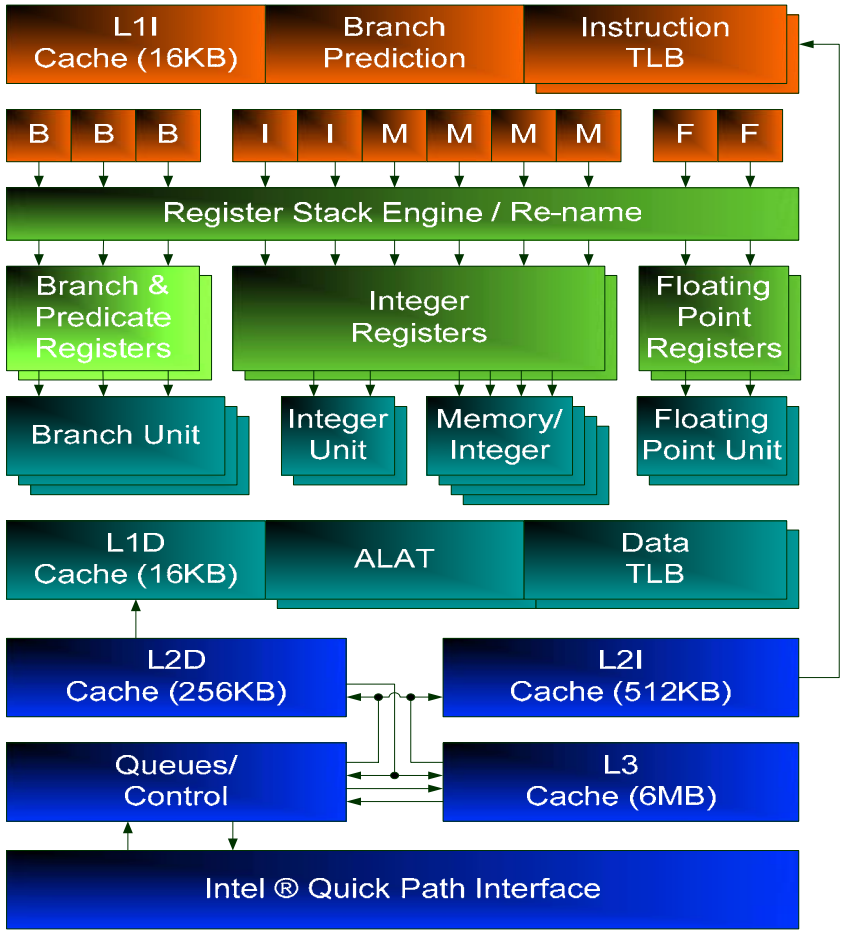
Intel® QuickPath Interconnect drives a leap forward in Platform Technology

- **Scalable solution**
  - Much higher link bandwidth than FSB
    - Headroom for higher transfer rates
  - Vastly greater MP system bandwidth with multiple, independent memory controllers and Intel QuickPath Interconnect links
    - Scales efficiently with number of processors
  - Many system topologies with more than four processors supported
  - Common interface for Intel® Itanium® and Xeon® processor-based systems
- **Improved system robustness**
  - Additional levels of error recovery and logging for mission critical systems

Highly Configurable System Interconnect

Intel® Itanium® Processor (Tukwila) Microarchitecture

- **Intel® Itanium® Processor (Tukwila) Leverages Intel® Itanium® Cores**
  - Proven EPIC architectures
  - Binary compatible with Intel® Itanium® processor family binaries
  - 2 Threads per Core
- **Intel Itanium Core Characteristics**
  - FAST and WIDE execution (6 wide instruction fetch and issue per cycle)
    - 6 wide integer units, 2 wide FP units
    - 4 wide very high bandwidth L1D and L2D cache ports
    - 1 cycle L1 data cache
    - Separate L2I and L2D caches
  - Short 8 stage pipeline – HIGH performance and energy efficiency
  - 50bit physical addressing



Intel Itanium Processor (Tukwila) Cores Exploit EPIC Opportunities

Virtualization Optimizations

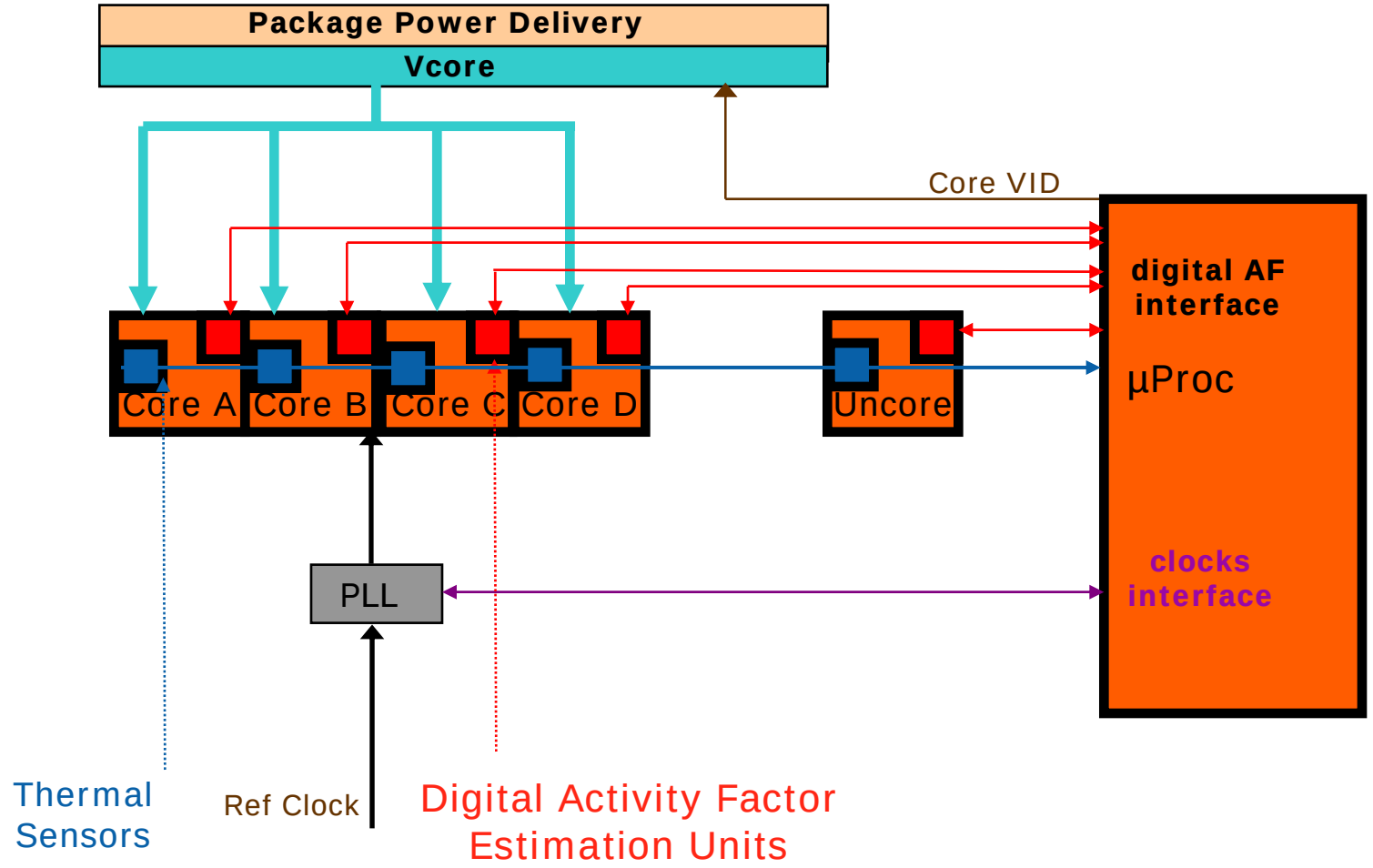
- **Intel® Itanium® architecture virtualization baseline (Intel® VT-i[1]):**
  - 1 new architecture state (new PSR.vm bit)
  - 2 new interruption vectors
  - New behavior on 29 current instructions
  - 1 new instruction (VMSW – virtual machine switch)
  - Mechanisms to protect host (VMM) virtual address space
  - Intel VT-i support in Processor Abstraction Layer (PAL)

- **Intel VT-i Extensions in Intel® Itanium® Processor (Tukwila):**
  - Goal: Reduce latency by reducing PAL emulation code and reducing virtualization faults.
  - New architecture state
  - New Guest copies of architecture state
  - New conditions using (selective) disable of virtualization faults
  - No VMM modification required to receive the benefits of these extensions

Focused on acceleration and optimization of virtualized environments

Intel® Virtualization Technology for Itanium® architecture (Intel® VT-i)
• [1]Supported starting with Itanium series 9000 processor.

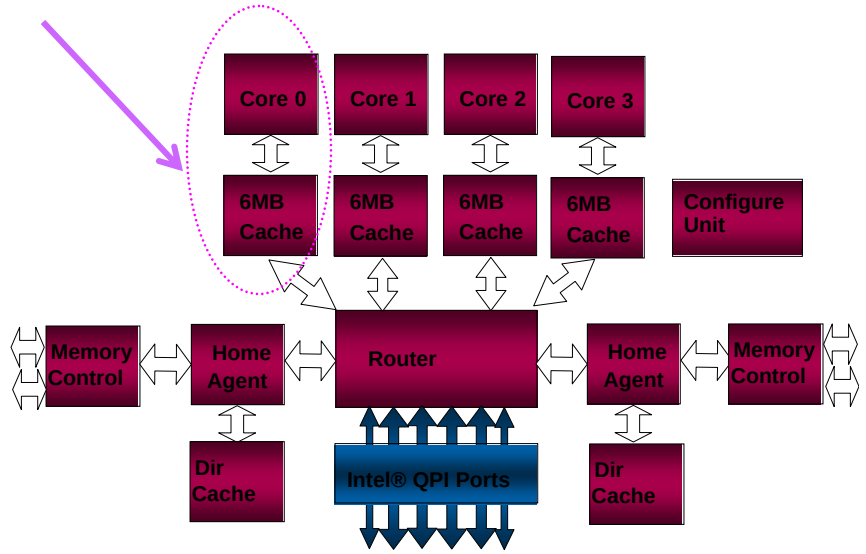
Voltage / Frequency Management



Allows balancing Performance and Power Savings as Needed

Caching Agent Overview

- **Caching Agent = Processor Cores + Cache + Interface to Router**
  - Four caching agents per socket
- **Converts from 128B cache line size in Core to 64B cache line size on QuickPath Interconnect.**
- **Each Caching agent supports up to 64 outstanding requests**
- **Supports forwarding of Exclusive or Modified state lines**

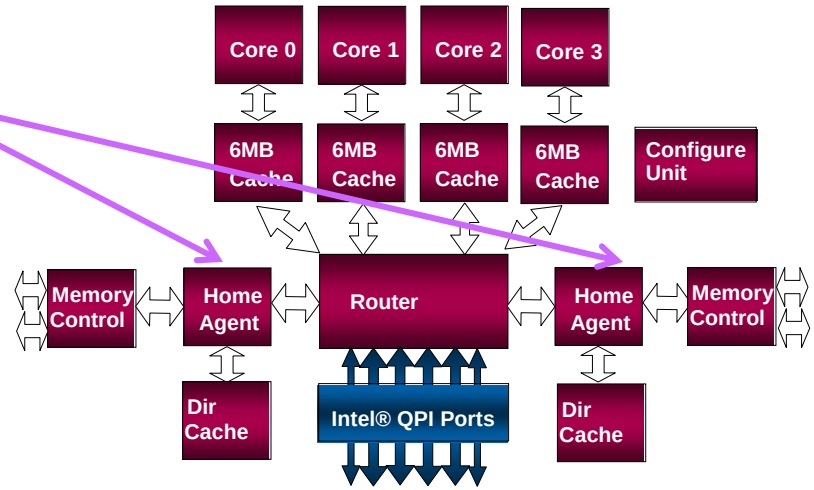


Caching Agent supports high per core bandwidth

Intel® QPI = Intel® QuickPath Interconnect

Home Agent Overview

- **Each Intel® Itanium® processor (Tukwila) socket has two home agents**
  - Home agent manages memory accesses to a section of the physical memory
- **Directory based cache coherency**



Intel® Itanium® Processor (Tukwila) Memory Controller

- **Intel® Itanium® processor (Tukwila) has two Integrated Memory Controllers (IMC)**
  - Each memory controller operates a pair of high speed lock-stepped channels
  - Each Memory channel is connected to a Memory Buffer
  - Supports DDR3 800
  - Supports 512MB to 16GB DIMMS
    - Capable of supporting 4 different DIMM types
    - Up to 4 DIMMS per channel
  - Supports up to 1TB memory per IMC

- **Memory scheduler optimized for bandwidth and latency**
  - Supports various open/close page modes: Open, Closed, or Adaptive Open/Close.
  - Capable of scheduling 3, 2 or 1 command per frame
  - Can operate on 32 simultaneous requests (reads and writes)

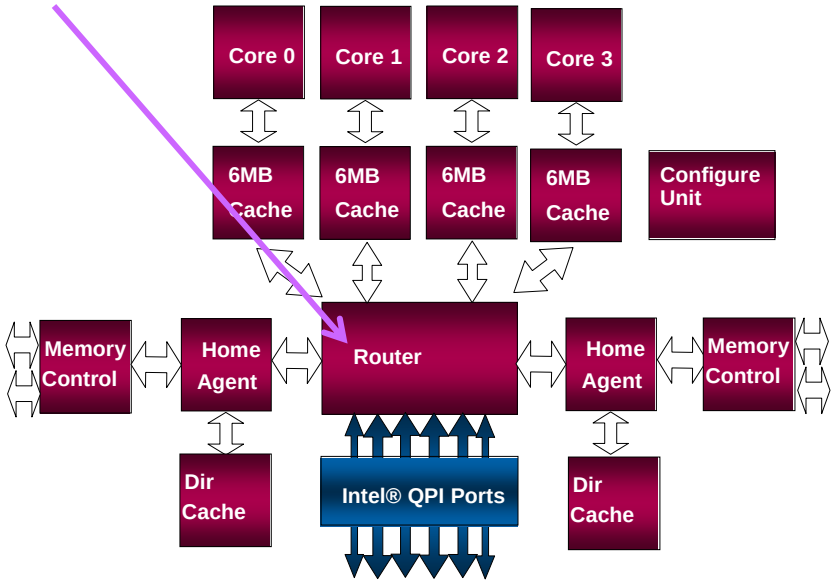
Memory Controller designed for performance and platform flexibility

Crossbar Router Overview

12 port switch / router responsible for routing and transmitting all intra- and inter-processor communication

- Routes packets between any two ports
- Internal ports have twice the bandwidth (19.2GB/s per direction) of Intel® QuickPath Interconnect ports

- **Implements 6 message classes and 3 virtual networks**
- **Supports snoop request broadcast to all cores within the socket**

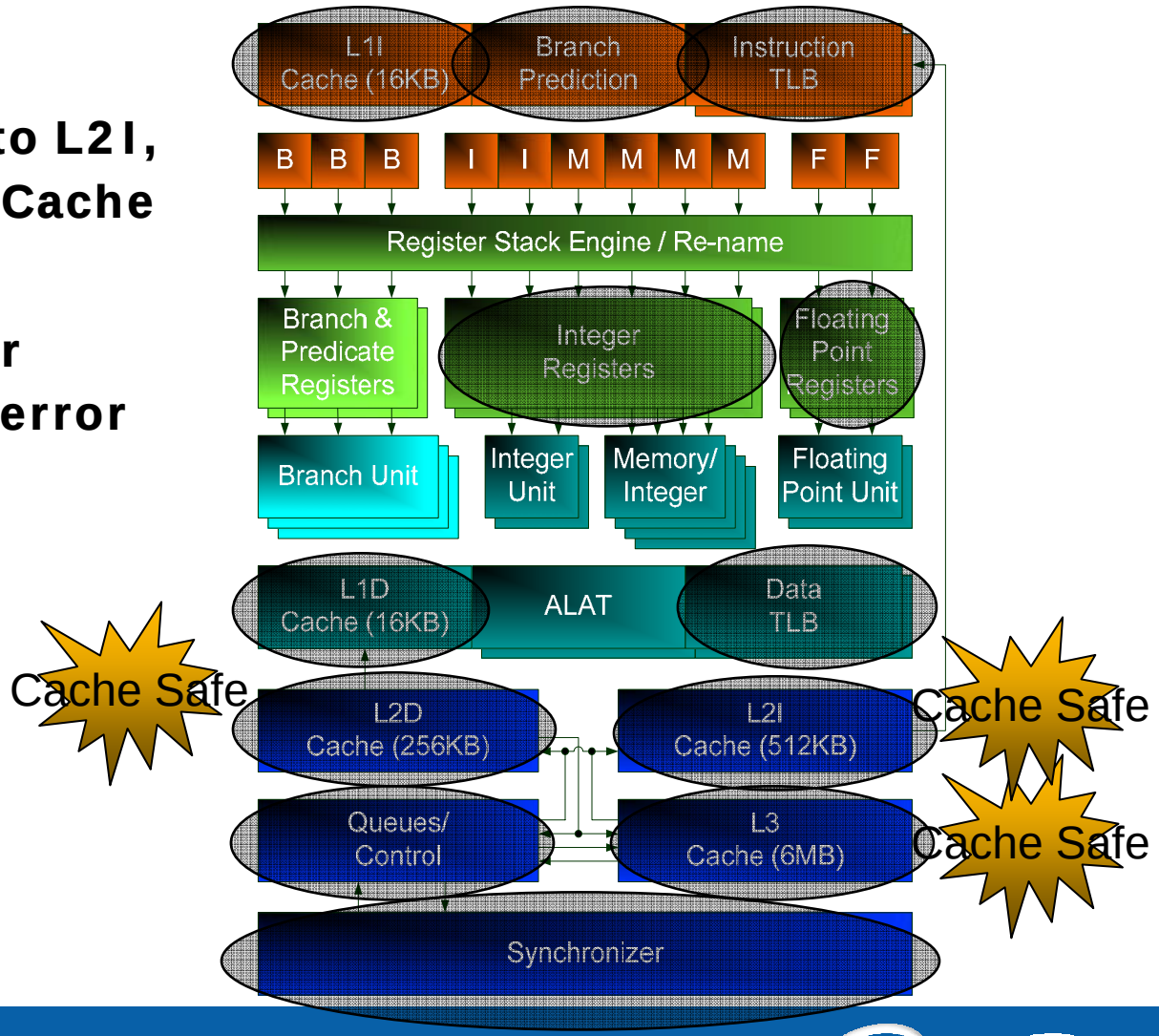


Crossbar designed for high bandwidth

Intel® Itanium® Processor (Tukwila) On-Die Error Protection

Core Error Protection

- **Intel® Cache Safe Technology added to L2I, L2D, and Directory Cache**
- **Improved Soft error protection via soft-error hardened circuits**

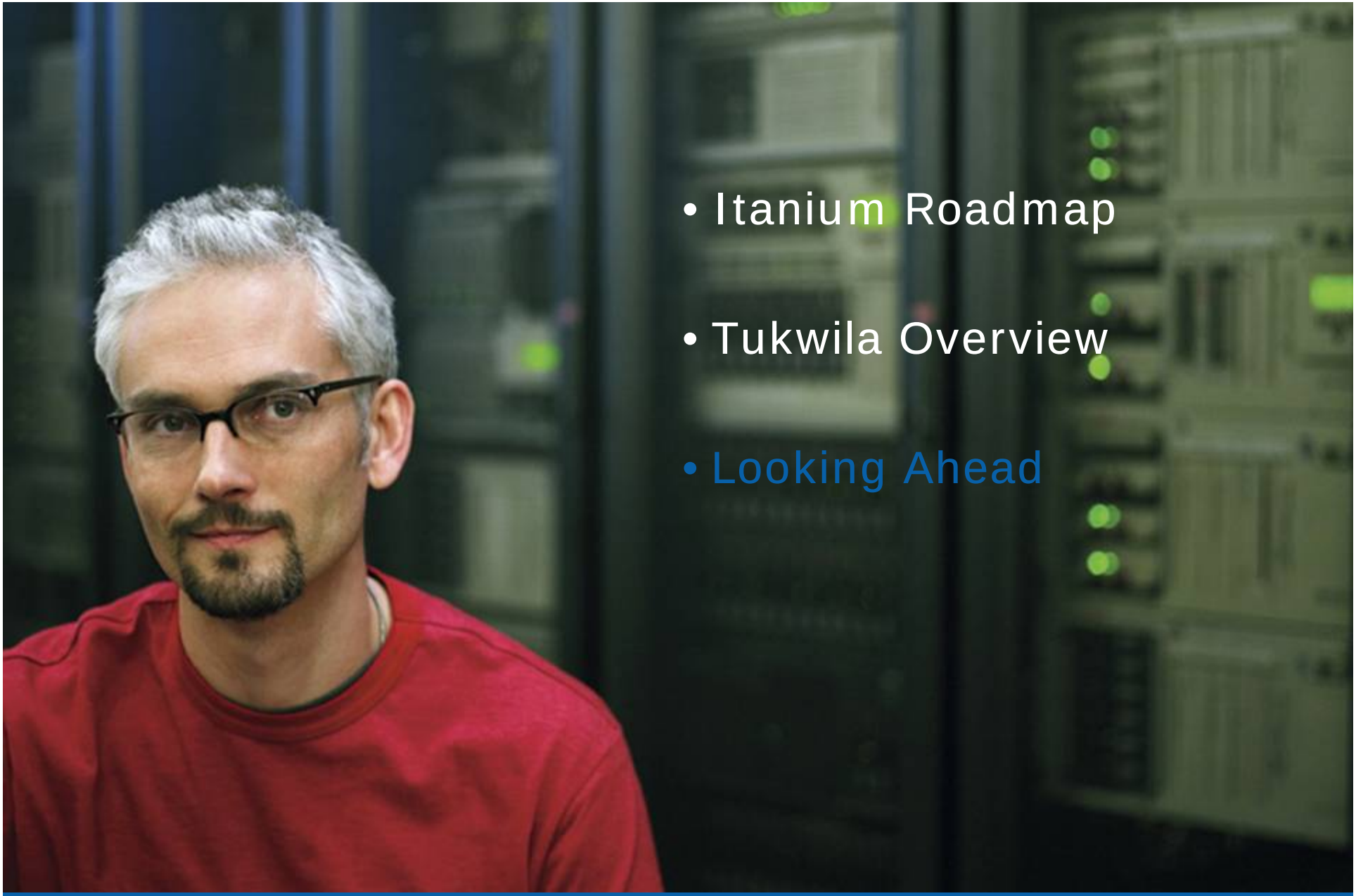


Intel® Itanium® Processor (Tukwila) Summary

Performance Leap	>2X Performance Increase over Itanium 9100
Higher Bandwidth	~9X CPU Bandwidth Increase with QuickPath Links with lower latency
Flexibility & Scalability	~6X Memory BW with Dual Integrated Memory Controllers
Richer RAS Features	Greater layout flexibility and scalability with QuickPath, FBD2, Directory
Better Virtualization	Enhanced Virtualization (VT-i2) and RAS features
New Technologies	New Itanium Technologies – QuickPath, FBD2, Partitioning, dynamic HW V/F Scaling

Tukwila designed for a leap in mission critical capabilities

Itanium inside



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Looking Ahead

- **Parallelism everywhere**
  - **Instruction level**
    - **Ultra-parallel micro-architecture**
    - **Improved speculation, prefetching support**
  - **Thread level**
    - **Enhanced multi-threading support**
  - **Core level**
    - **Advanced multi-core design**
- **Continue driving mission-critical attributes**
  - **Power efficiency**
  - **Virtualization**
  - **RAS**

Drive parallelism at all levels

intel Itanium inside

intel


intel®
Leap ahead™


intel
Itanium
inside


intel

Itanium® Momentum in the Marketplace

$10B ISA Investment, > 100 Members

> 75 of Top Global 100 Companies

> 164,000 End-User Deployments

40% Year on Year Growth[1]

> 12,000 Applications

Record $1B Revenue per Qtr

EPIC-7

*Other names and brands may be claimed as the property of others

1) Source: IDC Q2'07 Server Tracker